

General comments

The paper describes the environmental controls on gross primary production (GPP) and on total ecosystem respiration (TER) of a boreal Scots pine forest in Southern Finland using eddy covariance. The authors also applied two models (stand photosynthesis model and a generic dynamic vegetation model, ORCHIDEE) to simulate the productivity and respiration from this ecosystem. The main focus of the paper is on the environmental controls during autumn, as suggested from the title, but the authors also describe the controls on GPP and TER during the other seasons.

Overall the manuscript presents very interesting data. In fact it reports an impressive dataset (11 years of eddy covariance data) from a remote area of significant interest. However, the presentation is vague and confusing, and critical information is lacking. The paper needs to be reorganized and very carefully edited to enhance clarity. A different presentation of the data would allow the reader to understand the relevance of the results presented and put them in a bigger context.

The most important information missing that the authors should include is what percentage autumn GPP, and TER are of the entire year GPP and TER during these 11 years. Without this information is not possible to understand the importance of this season (and of the autumn warming) relatively to the annual carbon budget from the pine forest. Moreover, the authors present a statistical analysis of the driving factors of different seasons, but the title implies they are only interested in discussing data from autumn. If they want to include the differential environmental controls in different seasons, which could certainly be interesting, they should probably change the title. The same comment applies to the abstract. Moreover, the abstract is confusing: the presentation of the results from the correlation analysis and the modeling should be separate, so that the reader understands which results come from each of the analysis. A sentence describing the reason why these models were applied would also help to link these two parts.

A more accurate statistical analysis should also be included, involving multivariable models not only correlations coefficients in a single variable way.

This very interesting dataset should be presented in a clearer way, and the authors should show a time series analysis of GPP and TER in respect to temperature over the 11 years.

Furthermore, the discussion and conclusion should be further elaborated; these two sections should highlight the relevance of this study and the implication of the results for the climate change and carbon balance from the boreal forests.

Finally, a native English speaker should read the papers to improve clarity, some sentences are very confusing and there are several grammar errors.

Specific comments

Line 10 does the “stand photosynthesis model” have a name? The authors define the name of the generic dynamic vegetation model (ORCHIDEE), but not name of the first model.

Line 11 “also applied in the analysis”: not clear how these models were applied and why, are these models part of the correlation analysis (described in line 9) or a separate analysis? The results in line 11-17 come from which analysis? A more complete and organized discussion of the results would help the reader to understand the results. Maybe line 9-11 could be moved after line 11-17 so it would be clearer that these results come from the correlation analysis?

Lines 19-24 Not clear, please rewrite. This sentence is too long, maybe it is worth dividing it into two sentences.

Page 7056

Lines 5-8 more details (and numbers) should be provided to support this statement
Also, “asymmetric response” is maybe not the best way to define these results, replace with “non linear” or “complex”.

Line 10, which method? EC data is not a method eddy covariance is a method, please rephrase. Also lines 10-12 are confusing, GPP is not directly measured by eddy covariance please specify it is the sum of NEE and TER. Maybe move lines 19-21 before lines 10-12. Also this is not exactly true, at night EC measures TER, what you cannot measure is daytime TER and GPP, please rewrite and clarify.

Line 14 I assume Hari and Kulmala, 2008 were not the first to prove that GPP depends on radiation, please add more references.

Page 7057

Line 5, is this really the aim of this paper? It seems the main goal of the paper is to investigate the environmental drivers of NEE (GPP, and TER) as the authors states in lines 12-. If the authors’ goal is also to test the models performance they should mention it in the abstract.

Lines 13-21, There are no hypotheses here, Why did you perform the study? What is its relevance? Which hypothesis are you testing?

Page 7058

Lines 20-21 “above the forest at 23.3m height”, do you mean 23.3m above the forest, 46.6 m above the ground? Please clarify. Also, how much the forest grew during those 11 years? Did the distance of the instruments change comparing to the top of the forest?

Lines 27-28, “in some of the analyses the two-month periods” [...] “are considered separately”: based on what the authors separated these two periods and in which analyses? More details are needed.

Page 7059

Line 12 In the abstract the authors said that they compared the GPP from the EC data and from the ORCHIDEE model but here they said they replaced the missing GPP with a stand photosynthesis model, this is confusing, they should specify if they compared the GPP gap filled with the stand photosynthesis mode or the non gapfilled GPP with the ORCHIDEE model.

Page 7061

Line 14: The authors should be consistent in naming the models used and the paragraph 2.2.3 should be called “Generic dynamic vegetation model (ORCHIDEE)”, as this is the denomination introduced in the abstract. In case they prefer to use Global vegetation model, they should use this same name in the abstract.

Line 22: The authors should define CENTURY. Is it another model? A brief description of what this model is based on, would help the common reader.

Line 27 why the model is integrated for 10 years of data while the entire analysis involves 11 years?

Page 7062

Line 3: “There were three distinguishable years in terms of climate extremes in the autumn”, are the years or the autumns characterized by extremes? There should be more details.

Lines 21-24: The authors mention the effect of summer drought on respiration and GPP in August, but the focus of the paper is the autumn warming. Here and in the rest of the section, the focus should probably remain on the autumn months. On the other hand, if the authors think this is relevant to the paper they should change the title and the abstract (and probably the introduction) to broaden the discussion to the entire year.

Page 7063

Line 4: If the emphasis of the paper is to describe the extreme years, and the abnormal trends in early and late autumn of such years (2002, 2006) than Fig.2 is appropriate. In this case the authors should change the title, the abstract, and the introduction to reflect this goal. On the other hand, if the emphasis of the paper is on the long term warming and how this affects TER, NEE, and GPP during the 11-years, as the title and the abstract imply now, the data should be presented in a different way: Fig. 2 (and Fig.1) should have year (or autumn) on the x-axis. This would make it easier for the

reader to visualize the time series (autumn warming?) and its effects on the carbon dynamics of this ecosystem.

Line 6: what “cumulative” refers to? Year or autumn? Please specify.

Line 16; Not sure what “nights included” means? Is the daily GPP? If it is daily, of course the nights are included. Please clarify. Also, you may want to use $\mu\text{molm}^{-2} \text{d}^{-1}$ instead of $\mu\text{molm}^{-2} \text{s}^{-1}$ if you are talking about daily average.

Lines 18-19: Is radiation important for the GPP? It seems not enough to say “years with lowest Rg had generally the lowest GPP”; a more complete statistical analysis should be presented.

Line 21: The authors should give more details about the “extremely cloudy period”; change Fig. 1 and put year on the x-axis.

Lines 24-27: Same as before: the authors affirm that late autumn is irrelevant, and the early autumn is more relevant, but they should mention which percentage autumn GPP is of the entire year. This information is needed to draw any conclusion about the relevance of this period on the annual carbon budget.

Page 7064

Line 4: The authors use both years and autumn, creating confusion. They should pick one term and use it consistently. If they refer to the influence of autumn on the entire year budget they should specify it.

Lines 6-7: Same as before: how much the autumnal TER contributes to the annual TER?

Line 10: Figure 3, this figure is too busy

Paragraph 3.3: The authors should decide if they want to include the entire year or focus on the autumn period. I think the analysis of the different environmental controls in different seasons is very interesting but the authors should clarify that this is one of the goals of the papers in the title, abstract, and introduction.

Page 7065

Lines 9-10: “The correlation between GPP and temperature was low in early autumn but became statistically significant in November–December ($p < 0.05$)” The authors should be consistent when they describe the results: if the correlation was low in early autumn and became significant in late autumn, the authors should mention the correlation coefficients in both early and late autumn.

Line 12: how the authors removed the influence of temperature? They mentioned “partial correlation” but did not explain what they did? Did they use a multiple regression? Did they rank the environmental variable based on their explanatory power? A more complete description of the analysis they did should be included here.

Lines 15-16: Why temperature and radiation are negatively correlated? This is contra intuitive, as it is expected that temperature increase with increase radiation. Please explain.

Page 7066

Line 8: “it cannot”, what it refers to?

Line 10: Is “present” the past 11 years? Rephrase

Line 19: Erase “clearly”, a temperature is above or it is below zero. If the authors mean that the temperature is well above zero, they should mention the actual degrees above zero.

Page 7067

Line 4-5: Same as lines 15-16 on page 7065, the authors affirm that with “increasing temperature the cloudiness also increases which will reduce the predicted increase in GPP”, but considering that the increase in PAR also increases the temperature, some more explanation about this process should be added here.

Lines 13-14: “Such different response of NEE to early autumn temperature change was mainly due to the different response of GPP”: this is unclear, that authors state that the different effect of temperature on early autumn NEE (1/2 hour and daily) is due to the difference in GPP, but different time periods of GPP have the same signs, plus 1/2 hour and daily TER are similar. Please explain.

Page 7069

Lines 22-26: Too long and confusing, rewrite.

Technical corrections

Page 7056

Line 22-23 “utilized in quantification of processes...” Not clear, replace with “to quantify the impacts of autumn warming on GPP and TER respectively”.

Page 7057

Line 5 “The aim of this paper is to answer to these needs as regard to”, rewrite, change with “The aim of this paper is testing this model in a Scots pine forest”?

Page 7063

Lines 12-13: “The earliest CUP end was on day 272 (29 September) in 1999 and 2006 and latest on day 295 (22 October 2005)” change to “The earliest CUP end was on day 272 (29 September) in 1999 and 2006 and **the** latest on day 295 (22 October) **in** 2005”

Line 28: “followed closely the course of the soil” do you mean: are correlated with? Please rephrase.

Page 7064

Lines 2-3: “The inter-annual variability of TER, both in absolute and relative terms was markedly larger than in GPP, especially in late autumn”, the authors use variability of and variability in, they should be consistent, and also it is not clear what they refer to with “absolute and relative terms”. Rewrite sentence and make it clearer.

Page 7067

Line 4: “It is possible; however” erase the “;”

The title of this paragraph does not seem grammatically correct “3.6 Sensitivity tests by the dynamic global vegetation model” possibly change with “3.6 Dynamic global vegetation model sensitivity tests”

Page 7068

Line 1-3 :” This leads to the situation that during warmer autumns the studied pine forest (soil) is releasing larger amounts of carbon to the atmosphere” not grammatically correct, replace with “this leads to the carbon release observed during...”

Page 7069

Line 15: “the both periods” which periods are the authors referring to? Rewrite